SYSTEM AND METHOD FOR USING A MOBILE AGENT OBJECT TO COLLECT DATA

CROSS REFERENCE TO RELATED APPLICATION

[1] This application claims the benefit of co-pending Provisional Patent Application Serial No. 60/399,504 filed July 29, 2002 entitled "Using Mobile Agents to Collect Information Pushed From a Host System to a Mobile Communication Device."

TECHNICAL FIELD OF THE INVENTION

[2] The present invention relates, generally, to a distributed computing environment wherein processes created in an object-oriented environment direct their own movement throughout a computer network, and, in particular, relates to the use of mobile agent objects for the collection of data amongst various operating platforms.

BACKGROUND OF THE INVENTION

[3] The advent of computer networks has proliferated the use of distributed-computing environments. A distributed-computing environment is a type of computing wherein several computer platforms, *i.e.*, different computers, coupled by a network, perform separate but related tasks, (called a process), that are directed in concert toward a single achievement. One example of such a process is the retrieval of all files in a network having the same pattern of letters in the file name. By taking advantage of the computing power of several computers at once, tasks require less time for completion. Use of a processor

close to resources to be processed reduces total computing resource requirements.

[4] One method known in the art for practicing a distributed-computing environment is called "remote programming." In remote programming, a first executing program, called a client process, executing on a first computer system, sends to a second process, called a server process executing on the second computer system, a list of instructions. The instructions are then carried out on the second computer system by the server process, effectuating the goal of the client process. The instructions which the server process is designed to carry out must have some degree of generality, *i.e.,* the instructions must allow some degree of local decision-making with respect to details.

[5] U.S. Patent No. 6,016,393 to White et al., entitled, "System and Method for Distributed Computation Based upon the Movement, Execution, and Interaction of Processes in a Network", which is hereby incorporated by reference, discloses a system that improves upon the concept of remote programming by utilizing processes called mobile agents (sometimes referred to as mobile objects or agent objects). The system described by White et al., provides the ability for an object (the mobile agent object), existing on a first ("host") computer system, to transplant itself to a second ("remote host") computer system while preserving its current execution state. The operation of a mobile agent object is described briefly below.

[6] The instructions of the mobile agent object, its preserved execution state, and other objects owned by the mobile agent object are packaged, or "encoded", to generate a string of data that is configured so that the string of data can be transported by all standard means of communication over a computer network. Once transported to the remote host, the string of data is decoded to generate a computer process, still called the mobile agent object, within the remote host

system. The decoded mobile agent object includes those objects encoded as described above and remains in its preserved execution state. The remote host computer system resumes execution of the mobile agent object which is now operating in the remote host environment.

[7] While now operating in the new environment, the instructions of the mobile agent object are executed by the remote host to perform operations of any complexity, including defining, creating, and manipulating data objects and interacting with other remote host computer objects. Since mobile agent objects are known in the prior art, they will not be discussed further herein.

[8] Computer systems are often used to send and receive messages between a sender and a receiver. Examples of computer systems or platforms that facilitate the communication of messages include electronic mail via POP3 e-mail accounts, voice-mail over wireless networks, text messaging between two personal computer platforms, and many others. Messages on computer networks are often delivered to users via multiple unrelated communications channels, and often to different destination locations that can only be accessed locally by the user. Furthermore, each destination can typically only be accessed one at a time. Additionally, the messages that are sent to the user may not be messages the user wishes to receive, such as spam email. An automated method and system for the filtration, collection, and consolidation of important messages from different destination points is desirable.

[9] One such system is described in U.S. Patent No. 6,389,457 to Lazaridis et al., entitled "System and Method for Pushing Information From a Host System to a Mobile Data Communication Device" which is incorporated by reference.

[10] The system described by Lazaridis et al., involves placing a "redirector program" on a host machine ("collection host") that is configurable by a user.

Messages to the user are pushed to a user's mobile device by the redirector program based on user-defined event triggers set up within the redirector program. An event can be any exceptional occurrence within the collection host. Furthermore, whether a message is pushed to the user's mobile device or ignored can be a function of the message type, message contents, and any one of a number of preset filters available to the redirector program.

[11] Although this system provides the user the ability to filter messages, the ability to filter is limited to what filters are available to the redirector program. Furthermore, the system of Lazaridis et al. does not disclose a method for filtration of the messages at the message source platform and the subsequent redirection and delivery of the filtered messages other than conventional e-mail methods such as POP3. That is, all messages are sent to a single host platform prior to being filtered for parameters, such as content, time and date stamp, etc. By not filtering unwanted messages at the source of the message, unnecessary traffic is placed on a computer network prior to filtration.

SUMMARY OF THE INVENTION

[12] The present invention is directed to a method and system for collecting and filtering messages at an event source platform and delivering the filtered messages to a collection host platform. According to one embodiment, the method uses a mobile agent object to filter messages received at an event source platform. The mobile agent object determines a filtered set of messages that match predetermined parameters and then delivers the filtered messages to a collection host platform.

[13] Thus, in comparison to Lazaridis et al., instead of a fixed redirector program in the collection host platform, the ability to dynamically deliver a filtered set of messages from an event source platform through a mobile agent object to the collection host platform is realized. In addition to placing mobile agent objects in the event source platforms, similar mobile agent objects may be placed in the collection host platforms for redirecting the filtered messages to a plurality of different device platforms, such as a display device platform or a control device platform.

BRIEF DESCRIPTION OF THE DRAWINGS

[14] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[15] **FIG. 1** is a block diagram of one embodiment of distributed-computing environment suitable for practicing embodiments of the invention;

[16] **FIG. 2** is a block diagram of a system for configuring mobile agent objects for message collection, for collecting messages at a collection host platform from event source platforms, and for redirecting messages to destination platforms according to an embodiment of the invention;

[17] **FIG. 3** is an illustration of a method for configuring a mobile agent object to filter and collect messages;

[18] **FIG. 4** is an illustration of a method for the filtration and collection of messages received by an event source platform; and

[19] **FIG. 5** is an illustration of a method for the redirection of messages received at a collection host platform from mobile agent objects in event source platforms.

DETAILED DESCRIPTION

[20] **FIG. 1** is a block diagram of a distributed-computing environment suitable for practicing embodiments of the invention. The distributed-computing environment includes a first computer system ***100*** and a second computer system ***150*** that are coupled by a network connection, such as the internet ***125*** as shown in **FIG. 1**. The network connection may be any other connection, such as a Local Area Network (LAN) for example, that is suitable for facilitating communication between computer systems. Here, the first ***100*** and second ***150*** computer systems may communicate over the internet ***125*** using a standard protocol, such as, for example, Transmission Control Protocol/Internet Protocol (TCP/IP). Additionally, there are typically many more computer systems (not shown) coupled with the internet ***125***, all of which may communicate with other computers on the network including the first and second computers ***100*** and ***150***.

[21] The first computer system ***100*** includes a CPU ***103*** coupled to a bus ***101*** that facilitates communication between the CPU ***103*** and other components of the computer ***100***. Other components of the computer ***100*** include a Network Interface Component ***102*** (NIC) and a memory ***104***. The memory may include magnetic or optical disks, Random-Access memory (RAM), Read-Only memory (ROM), Basic Input/Output Systems (BIOS), or any other commonly known

memory system used in computer architecture. In the first computer ***100***, a mobile-agent runtime environment ***110*** and a mobile agent injector program ***111*** are resident within the memory ***104***. Although shown as separate memory components, the mobile-agent runtime environment ***110*** and a mobile agent injector program ***111*** may reside in a single memory component or in any combination of memory components that are coupled with the bus ***101***. The NIC ***102*** facilitates communications between the first computer ***100*** and other computers, such as the second computer ***150***, via the internet ***125***.

[22] The second computer ***150*** is similar to the first computer ***100*** and includes a CPU ***153***, a bus ***151***, a NIC ***152***, and a memory ***154*** which includes a mobile-agent runtime environment ***160***. These components are organized and coupled as described above with respect the first computer ***100***.

[23] The above-described distributed-computing environment may host one or more mobile agent objects (not shown) that are present in one of the mobile-agent runtime environments ***110*** or ***160*** of one of the computers ***100*** or ***150***. The mobile-agent runtime environment ***110*** and ***160*** is a portion of the memory dedicated to allowing a mobile agent object the ability to perform operations that it was programmed to carry out. The nature of the mobile agent object, the manner in which the mobile agent object is transported between computers, and the parameters of the mobile agent object's abilities are discussed in detail in White et al. (which has been incorporated by reference) and will not be discussed further herein.

[24] Mobile agent objects may be instantiated in a mobile-agent runtime environment ***110*** or ***160*** in several ways, two of which are briefly described here. In a first way, the mobile agent object is locally created in the first computer ***100*** and then locally injected into the mobile-agent runtime environment ***110*** by the mobile agent injector program ***111***. In a second way, the mobile agent object

moves from the mobile-agent runtime environment ***110*** of the first computer system ***100*** to the mobile-agent runtime environment ***160*** of the second computer system ***150*** over the internet ***125*** by its own accord, *i.e.*, according to its programmed instructions. Both of these instantiation processes are well known in the prior art.

[25] **FIG. 2** is a block diagram of a system ***200*** for configuring mobile agent objects for message collection, collecting messages at a collection host platform from event source platforms; and redirecting messages to destination platforms according to an embodiment of the invention. The system ***200*** includes several computing environments and/or platforms (similar to the first ***100*** and second ***150*** computer systems of **FIG. 1**) coupled by network connections ***201***. The network connections ***201***, as in **FIG. 1**, may be the internet ***125*** that use standard TCP/IP communications.

[26] The platforms coupled by the network connections ***201*** in the system ***200*** include control device platforms ***205*** and ***206***, a collection host platform ***210***, event source platforms ***220*** and ***230***, and display device platforms ***215*** and ***216***. The system ***200*** may include one or more of each of the above-mentioned platforms with each platform operable to host a mobile agent object within one or more mobile-agent runtime environments ***160*** running therein, respectively. Each platform is described in greater detail below.

[27] A plurality of control device platforms ***205*** and ***206***, usually remote from the collection host ***210***, typically comprise desktop PCs, server computers, or mobile devices capable of wireless or wired communications over the network connection ***201***. A control device platform ***205*** or ***206*** serves as the origin of a mobile agent object to be used for message filtration and collection. As such, a control device platform **205** and **206** is differentiated from other platforms by the inclusion of a mobile-agent-object toolkit ***207*** or ***208.***

[28] A mobile-agent-object toolkit ***207*** or ***208*** is a set of software routines for dispatching custom-made or pre-created mobile agent objects which exist in a mobile-agent-object toolkit library (not shown). Specifically, the mobile-agent-object toolkit ***207*** or ***208*** is used to create mobile agent objects which function as message filters, event triggers, and/or delivery mobile agent objects (described below) to be dispatched to a collection host platform ***210*** or event source platforms ***220*** and/or ***230***. Mobile-agent-object toolkits ***207*** and ***208*** typically only exist on control device platforms ***205*** and/or ***206***.

[29] A mobile-agent-object toolkit ***207*** and ***208*** is used to configure a mobile agent object for message filtering and collection through user-entered control vectors ***209***. Control vectors ***209*** are realized by input methods such as touch pads, keyboards, or pointing devices coupled with appropriate control software, DTMF tones over a telephone translated by appropriate software into commands, voice enabled command interfaces, instant messaging protocols, custom-built control client software, and external automated systems. Control vectors ***209*** are characterized by their ability to translate external command protocols into digital commands understood by the mobile-agent-object toolkit ***207*** or ***208***. A method for mobile agent object configuration is described below in conjunction with **FIG. 3**.

[30] Once a mobile agent object is configured, it may be delivered to another platform, such as the collection host platform ***210***. The collection host platform ***210*** is operable to host one or more mobile agent objects that are capable of moving from platform to platform according to each mobile agent object's programmed instructions. If a particular mobile agent object has been configured for message filtering, the mobile agent object typically passes to another platform, such as an event source platform ***220*** or ***230*** to collect relevant messages. If, however, the particular mobile agent object has been configured

for host message collection and/or message redirection, the mobile agent object, called a delivery mobile agent object ***212***, typically remains resident in the collection host platform ***210***.

[31] The collection host platform ***210*** also includes an associated message database **211** suitable for storing digital representations of messages. As such, when a mobile agent object executing on an event source platform ***220*** or ***230*** sends a relevant message to the collection host platform ***210***, the delivery mobile agent object ***212*** executing on the collection host platform ***210*** facilitates the storage of the relevant message in the message database ***211*** and/or the subsequent redirection of the message to be delivered to another platform, such as a display platform ***215*** or ***216*** or to a control platform ***205*** or ***206***. A method for message redirection is described below in conjunction with **FIG. 5**.

[32] Event source platforms ***220*** and ***230*** are capable of receiving, through any number of communications channels and protocols, messages intended for a user with access to the event source platforms ***220*** and ***230***. An event source platform ***220*** or ***230*** may be, for example, a voice-message system for a mobile telephone, a remote email address accessible via POP3 protocol, an FTP address, etc. Event source platforms ***220*** and ***230*** are characterized by their ability to translate received messages into a digital format that can be read, translated, and transferred by mobile agent objects ***221*** and ***231***. As such, when a message is received at an event source platform ***220*** or ***230***, a mobile agent object ***221*** or ***231*** running thereon filters to the received message to determine if the message is relevant. Relevancy can be any user-programmed parameter, such as message source, subject matter, time and date stamp, etc. If relevant, the message is passed on to the collection host platform ***210***. A method for message collection is described below in conjunction with **FIG. 4**.

[33] The system ***200*** further includes a plurality of display device platforms ***215*** and ***216*** which are platforms capable of displaying a representation of the original message as received by one of the event source platforms ***220*** or ***230***. Often display device platforms ***215*** and ***216*** also have the capabilities of control device platforms ***205*** and ***206***. Examples of display device platforms ***215*** and ***216*** include fax machines, desktop PCs, network printers, and mobile telephones with display screens. When messages are redirected by the collection host platform ***210***, they are often sent to one or more display device platforms ***215*** and ***216***.

[34] **FIG. 3** is an illustration of a method for configuring a mobile agent object for the filtration and collection of messages. The method is a process by which mobile agent objects representing message filters and event triggers are configured and then dispatched to a collection host platform ***210*** and/or event source platforms ***220*** and ***230***.

[35] At step ***301***, a command is sent over a control vector ***209***, to a mobile-agent-object toolkit **207** or **208** with instructions to configure a mobile agent object. The control vector contains a set of instructions that configures a mobile agent object with a plurality of event triggers and a plurality of message property requirements that together comprise a filter. An event trigger is a set of instruction that allows a mobile agent object to recognize the occurrence of an event, such as, the receiving of an email at an event source platform ***220*** or ***230***. A message property requirement is a parameter or characteristic of a message that the mobile agent object may scrutinize to determine if the message is to be passed on to the collection host platform ***210***. Examples of message property requirements include the recipient identification, the subject matter of the message, the time and date stamp of the message, etc.

[36] The mobile agent object is then configured at step ***303*** with appropriate event trigger and message property requirements as well as a delivery address

where messages which pass the filter are to be delivered. Alternatively, a pre-configured mobile agent object may be selected, at step ***305***, from a mobile-agent-object database (not shown) that is local to one of the control device platforms ***205*** or ***206***.

[37] Next, at step ***307***, depending on the intended function of the configured mobile agent object, the agent is deployed to a event source platform ***220*** or ***230*** to become a constituent of the resident event trigger/filtering agency, *i.e.*, mobile-agent-object environment ***221*** or ***231***, or is deployed to a collection host platform ***210*** to become a constituent of the resident delivery agency, *i.e.*, mobile-agent-object environment ***212***. In the case of an event source platform ***220*** or ***230***, the mobile agent objects dispatched are those that are configured to serve message filtration and collection purposes. In the case of a collection host platform ***210***, the mobile agent objects dispatched are configured to serve message redirection and storage purposes. Finally, at step ***309***, the particular platform (collection host platform ***210*** or event source platform ***220/230***) takes over execution of the mobile agent object within their respective agencies ***212*** or ***221/231***.

[38] **FIG. 4** is an illustration of a method for the collection of messages received by an event source platform ***220*** or ***230***. In this method, mobile agent objects, configured using the configuration method of **FIG. 3**, work together to filter and collect messages at event source platforms ***220*** and ***230*** which meet a particular requirement of a user. The requirements are encoded as the event triggers and message properties contained within the mobile agent objects from configuration. Once determined to be relevant, *i.e.*, filtered, messages are sent to a collection host platform ***210*** and stored in a message database ***211*** for later retrieval by a redirection method described below with respect to **FIG. 5**.

[39] To begin, the method of **FIG. 4** a mobile agent object executes in an event source platform ***220*** or ***230*** at step ***401***. During execution, the configured mobile

agent object monitors the activity of the event source platform ***220*** or ***230*** for particular events according to its configured instructions as defined by the plurality of event triggers encoded therein. When an event occurs on the event source platform ***220*** or ***230***, at step ***403***, the mobile agent object is triggered if the event is one of the mobile agent object's trigger events. Events that can trigger a mobile agent object include, but are not limited to, the insertion of a mobile agent object into a platform, a timer event, and/or the reception of a new unfiltered message into the platform.

[40] As such, at step ***405***, if the mobile agent object is triggered, then the mobile agent object determines if the event is relevant by passing the message through its filter as defined by its message property requirement encoded therein. That is, the mobile agent object determines if the event, (the receiving of a message, for example) passes its filter, (the recipient being a particular user, for example).

[41] At step ***407***, if the event is not relevant, then the mobile agent object discards the message and continues executing on the event source platform ***220*** or ***230*** (back to step ***401***). If, however, the mobile agent object determines that the event is relevant, then information about the event is assembled and delivered to a platform corresponding to the mobile agent object's programmed delivery address. The platform corresponding to the delivery address is typically a collection host platform ***210***, but may be any platform suitable to receive information about events collected by a mobile agent object. Once the information is sent to the appropriate platform, the mobile agent object continues to execute on the event source platform ***220*** or ***230*** while monitoring future events (back to step ***401***).

[42] **FIG. 5** is an illustration of a method for the redirection of messages received at a collection host platform ***210*** from mobile agent objects executing in

event source platforms ***220*** or ***230***. At step ***501***, an event occurs which is important to a constituent, *i.e.,* a delivery mobile agent object, of the delivery agency ***212***, causing the process encoded in the constituent to execute. For example, a message may be received from mobile agent object ***221*** or ***231*** executing on an event source platform ***220*** or ***230***. Alternatively, the event may be a message database ***211*** search request from a control device platform ***205*** or ***206***.

[43] When an event occurs, the delivery mobile agent object determined the relevancy of the event according to its configured parameters at step ***503***. Events that trigger constituents of a delivery agency ***212*** include, but are not limited to, the insertion of a mobile agent object into a platform, a timer event, the reception of a new message into the message database ***211***, and/or external commands conforming to externally-defined protocols issued by a control device platform ***205*** or ***206***. For example, the event may trigger a delivery mobile agent object to parse a message to determine (according to its filter instructions, at step ***505***) whether to send the message to a display device platform ***215*** or ***216*** at step ***507***, to a control device platform ***205*** or ***206*** at step ***509***, or to message database ***211*** on the collection host platform ***210*** at step ***511***. Alternatively, the event may trigger the delivery mobile agent object to deliver a message to more than one destination.

[44] The preceding discussion is presented to enable a person skilled in the art to make and use the invention. The general principles described herein may be applied to embodiments and applications other than those detailed below without departing from the spirit and scope of the present invention. The present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed or suggested herein.